

REMARKS

This amendment is responsive to the Final Office Action dated September 28, 2007. Claims 33 – 38 are pending in this application and have been rejected.

Reexamination is respectfully requested.

Applicant has amended claims 33 – 38 to specify that the metal layers are of Ag and not of Au. These amendments are supported by Figure 1 of the specification. For example, in Figure 1, and also at page 15, lines 5 – 17.

Applicant has added new claims 90 – 95 which are supported by figure 9, which includes Ag-base layer (310c).

In the outstanding Office Action, the examiner has cited Yasutimi '100 as having a metal layer (32). Applicant has obtained a machine translation of '100 (attached hereto). It is clear from the machine translation that the metal layer referred to by the examiner is a blocking layer. As disclosed in the machine translation, layer (32) may also comprise nickel.

The claims 33 - 38 as now amended include Ag in the layers, and not Au. New claims 91 – 95 have a main metal layer made with Ag and Au.

In view of the foregoing, it is respectfully submitted that the application is now in condition for allowance, and early action in accordance thereof is requested. In the event there is any reason why the application cannot be allowed in this current

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Docket No.: **SUG-176-USAP**

condition, it is respectfully requested that the Examiner contact the undersigned at the number listed below to resolve any problems by Interview or Examiner's Amendment.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'Ronald R. Snider', is written over the typed name.

Ronald R. Snider
Reg. No. 24,962

Date: December 27, 2007

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In the component indicated by the above-mentioned reference, as a silicon single crystal substrate 101 with which the metal layer 110 is formed, as what was covered with the thick insulator layer 102 which consists of SiO₂ is used and it is shown in drawing 14 The energization to the cap layer 105 and the luminous layer sections 106-108 It is made to carry out, without minding an insulator layer 102 between said Au layers 104 and electrodes 109, using as an electrode the part exposed to the outside of the cap layer 105 and the luminous layer sections 106-108 in the Au layer 104. therefore -- this structure -- the terminal drawing structure of a component -- complicated -- not becoming -- it does not obtain but there is a fault which leads to **** of a manufacture man day, as a result a price hike of a component.

[0007] The optical drawing effectiveness from a component of the technical problem of this invention is good, and in addition, its terminal drawing structure of a component is simple, and is to offer the light emitting device excellent in convenience, and its manufacture approach.

[Translation done.]

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CLAIMS

[Claim(s)]

[Claim 1] The light emitting device which a metal layer, the luminous layer section, and the first electrode are formed in the first Lord front-face side of a conductive substrate in this sequence, and is characterized by the energization to said luminous layer section being possible through said first electrode and said conductive substrate.

[Claim 2] The light emitting device according to claim 1 which said conductive substrate is a silicon single crystal substrate, and is characterized by forming the second electrode in the second Lord front-face side of this silicon single crystal substrate.

[Claim 3] The light emitting device according to claim 2 characterized by forming said metal layer directly in contact with said silicon single crystal substrate.

[Claim 4] Said metal layer is a light emitting device according to claim 3 characterized by forming Au in a principal component.

[Claim 5] Said metal layer is a light emitting device according to claim 3 characterized by including the first metal layer which touches said silicon single crystal substrate, and the second metal layer which touches said luminous layer section.

[Claim 6] Said first metal layer is a light emitting device according to claim 5 characterized by forming in a principal component silicon and the metal component which is easy to alloy rather than the metal component used as the principal component of said middle metal layer, including further the middle metal layer to which said metal layer touches said first metal layer between said first metal layers and said second metal layers.

[Claim 7] Said first metal layer is a light emitting device according to claim 6 characterized by forming the metal component with eutectic temperature lower than the metal component used as the principal component of said middle metal layer with silicon in a principal component.

[Claim 8] It is the light emitting device according to claim 7 characterized by forming said first metal layer in a principal component in Au, and forming said middle metal layer in a principal component in aluminum.

[Claim 9] Said second metal layer is a light emitting device according to claim 5 or 6 characterized by a subject constituting Au.

[Claim 10] The light emitting device according to claim 1 characterized by forming said conductive substrate with the quality of the material which has translucency, and forming the optical passage section in said metal layer.

[Claim 11] The conductive substrate of said translucency is a light emitting device according to claim 10 characterized by being a GaP substrate.

[Claim 12] The first conductivity-type cladding layer to which said luminous layer section is located in said first electrode side, It has a terrorism structure layer to the double which consists of the second conductivity-type cladding layer located in said metal layer side, and a barrier layer formed between said first conductivity-type cladding layers and said second conductivity-type cladding layers. Furthermore, the light emitting device according to claim 1 characterized by having the first conductivity-type current

diffusion layer formed between said first electrode and said first conductivity-type cladding layers.

[Claim 13] The light emitting device according to claim 12 characterized by said first conductivity-type cladding layer and said current diffusion layer being p mold.

[Claim 14] It is the light emitting device according to claim 12 or 13 characterized by for a terrorism structure layer consisting of AlGaInP mixed crystal to said double, and said current diffusion layer consisting of AlGaAs mixed crystal or AlGaAsP mixed crystal.

[Claim 15] the [the process which carries out epitaxial growth of the luminous layer section on a semiconductor single crystal substrate, and / of a conductive substrate] -- the [of a 1 main front face and said luminous layer section] -- the manufacture approach of the light emitting device characterized by performing junction down stream processing which joins a 1 main front face only through a metal layer, and the process which separates or removes said semi-conductor single crystal substrate in this order.

[Claim 16]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The mimetic diagram showing some examples of outline structure of the light emitting device of this invention.

[Drawing 2] The mimetic diagram showing the example of the concrete laminated structure of the light emitting device of drawing 1 (a).

[Drawing 3] The explanatory view showing the first example of a production process of the light emitting device of drawing 2 .

[Drawing 4] The explanatory view showing the second example similarly.

[Drawing 5] The explanatory view showing the third example similarly.

[Drawing 6] The mimetic diagram showing the first modification of the metal layer in the light emitting device of drawing 2 .

[Drawing 7] The mimetic diagram showing the second modification similarly.

[Drawing 8] The mimetic diagram showing the example of the light emitting device using a metal substrate.

[Drawing 9] Drawing explaining signs that curvature occurs in the light emitting device substrate obtained by removing a semi-conductor single crystal substrate after junction.

[Drawing 10] Drawing explaining the difference in layer thickness with the case where it considers as the case where the conductivity type of a current diffusion layer is used as p mold, and n mold.

[Drawing 11] The mimetic diagram showing the example of the light emitting device which used the cladding layer and current diffusion layer by the side of the first electrode as n mold.

[Drawing 12] The mimetic diagram showing the example of the light emitting device which uses the conductive substrate substrate of translucency and forms the optical passage section in a metal layer with the operation.

[Drawing 13] The mimetic diagram showing the various patterns of the optical passage section formed in a metal layer.

[Drawing 14] The mimetic diagram showing the structure of the conventional light emitting device.

[Drawing 15] The mimetic diagram showing the reflex path of the light by the light emitting device of drawing 14 .

[Description of Notations]

1, 100, 200, 210, 220, 240 Light emitting device

2 Conductive Substrate

3 Metal Layer

4 Luminous Layer Section

5 First Electrode

6 Second Electrode

21 Metal Substrate (Conductive Substrate)

31 First Metal Layer

32 Middle Metal Layer

33 Second Metal Layer
41 N Mold AlGaInP Cladding Layer
42 AlGaInP Barrier Layer
43 P Mold AlGaInP Cladding Layer
44 Current Diffusion Layer
61 Semi-conductor Single Crystal Substrate
141 Optical Passage Section

[Translation done.]



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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a light emitting device and its manufacture approach.

[0002]

[Description of the Prior Art] The photoelectric conversion efficiency in the interior of a component is approaching a theoretical limitation gradually as a result of the advance over many years in the ingredient and component structure which are used for light emitting devices, such as light emitting diode and semiconductor laser. Therefore, when it is going to obtain the component of much more high brightness, the optical drawing effectiveness from a component becomes very important. The approach of joining the semi-conductor substrate of light transmission nature to the luminous layer section is proposed so that the light which goes to a substrate side from the luminous layer section can also be contributed to luminescence as an approach of raising optical drawing effectiveness. However, generally, when it is going to join the semi-conductor substrate of light transmission nature to the luminous layer section directly, since it will be easy to become complicated and the junction processing in an elevated temperature is needed, the process has the problem on which the luminous layer section tends to deteriorate.

[0003] Next, the light emitting device in which the luminous layer section was formed with AlGaInP mixed crystal can realize the component of high brightness by adopting terrorism structure to the double which sandwiched the thin AlGaInP (or GaInP) barrier layer in the shape of sandwiches by the n mold AlGaInP cladding layer with a larger band gap than it, and the p mold AlGaInP cladding layer. Terrorism structure can be formed in such AlGaInP double using AlGaInP mixed crystal carrying out lattice matching to GaAs by carrying out epitaxial growth of each class which consists of AlGaInP mixed crystal on a GaAs single crystal substrate. And in case this is used as a light emitting device, a GaAs single crystal substrate is usually used as a component substrate as it is in many cases. However, since the band gap is larger than GaAs, the AlGaInP mixed crystal which constitutes the luminous layer section has the difficulty which the light which emitted light is absorbed by the GaAs substrate and sufficient optical drawing effectiveness cannot acquire easily. In order to solve this problem, the approach (for example, JP,7-66455,A) of inserting the reflecting layer which consists of semi-conductor multilayers between a substrate and a light emitting device is also proposed, but since the difference in the refractive index of a semi-conductor layer by which the laminating was carried out is used, only the light which carried out incidence at the limited include angle is reflected, and the large improvement in optical drawing effectiveness cannot be expected theoretically.

[0004] On the other hand, as shown in the latest reference (Applied Physics Letters, 75 (1999) 3054) at drawing 14, the proposal which inserts the metal layer which made Au the subject between the luminous layer section which has terrorism structure to AlGaInP double, and a silicon single crystal substrate is made. On SiO two-layer 102 which the light emitting device 100 shown in drawing 14 oxidizes n mold silicon single crystal substrate 101, and is formed, the AuBe layer 103 and the Au layer 104 are formed as a metal layer 110, and, specifically, the electrode 109 which consists of the p mold

GaAs cap layer 105, the p mold AlGaInP cladding layer 106 which makes terrorism structure to double, the AlGaInP barrier layer 107, an n mold AlGaInP cladding layer 108, and an AuGeNi/Au layer further is formed. The light generated in the barrier layer 107 is reflected in the Au layer 104, as shown in drawing 15.

[0005] According to this structure, since the metal layer 110 functions as a reflecting mirror, the high reflection factor independent of whenever [incident angle] is realized, and optical drawing effectiveness can be raised sharply. However, since it is impossible to grow up an AlGaInP mixed-crystal layer directly on a metal layer in this case, the following approaches are adopted. First, the silicon single crystal substrate 101 which formed the metal layer 110 by vacuum evaporation, and the GaAs single crystal substrate to which epitaxial growth of the luminous layer section which has the terrorism structures 106, 107, and 108 to AlGaInP double, and the GaAs cap layer 105 was carried out are prepared separately. Subsequently, after joining both substrates between the metal layer 110 and the cap layer 105, a GaAs single crystal substrate is removed, a required electrode is formed, and it considers as a component.

[0006]

[Problem(s) to be Solved by the Invention] In the component indicated by the above-mentioned reference, as a silicon single crystal substrate 101 with which the metal layer 110 is formed, as what was covered with the thick insulator layer 102 which consists of SiO₂ is used and it is shown in drawing 14. The energization to the cap layer 105 and the luminous layer sections 106-108 It is made to carry out, without minding an insulator layer 102 between said Au layers 104 and electrodes 109, using as an electrode the part exposed to the outside of the cap layer 105 and the luminous layer sections 106-108 in the Au layer 104. therefore -- this structure -- the terminal drawing structure of a component -- complicated -- not becoming -- it does not obtain but there is a fault which leads to **** of a manufacture man day, as a result a price hike of a component.

[0007] The optical drawing effectiveness from a component of the technical problem of this invention is good, and in addition, its terminal drawing structure of a component is simple, and is to offer the light emitting device excellent in convenience, and its manufacture approach.

[0008]

[Means for Solving the Problem and its Function and Effect] In order to solve the above-mentioned technical problem, a metal layer, the luminous layer section, and the first electrode are formed in the first Lord front-face side of a conductive substrate in this sequence, and the light emitting device of this invention is characterized by the energization to the luminous layer section being possible through the first electrode and a conductive substrate.

[0009] According to the above-mentioned structure, in addition to good optical drawing effectiveness being realizable, in the light emitting device which inserted the metal layer between a substrate and the luminous layer section, it becomes possible by using reflection in a metal layer to form an electrode or a terminal in the both sides of a light emitting device. It becomes unnecessary that is, to make it the complicated structure of unlike the light emitting device (drawing 14) of the above mentioned reference exposing a metal layer to the side of the luminous layer section, and forming a terminal takeoff connection. Therefore, while it is simplified sharply and the terminal drawing structure of a component can reduce a chip size, the light emitting device excellent in convenience is realized.

[0010] As shown in drawing 1, the energization direction to the layered product 9 which consists of the conductive substrate 2, a metal layer 3, and the luminous layer section 4 is all possible also at the polarity from which the first electrode side serves as forward, as are shown in (a), and the polarity from which the first electrode side serves as negative also shows to (b). In this case, the built-up sequence of the heterojunction structure in the luminous layer section 4 becomes reverse at (a) and (b).

[0011] The conductive substrate 2 can also be used as semi-conductors, such as a silicon single crystal, and can also be used as metals, such as aluminum. When using the conductive substrate 2 as a semi-conductor, as shown in drawing 1, the second electrode 6 is formed in the second Lord front-face side of the conductive substrate 2, and the second terminal 12 is further formed in this second electrode 6. In this case, it becomes the form where energization is made between the first electrode 5 and the second

electrode 6. On the other hand, since the direct formation of the second terminal 12 can be carried out at the conductive substrate 2 when using the conductive substrate 2 as a metal, the second electrode 6 can also be omitted. In addition, when adopting a semi-conductor as a conductive substrate 2, in two viewpoints, raise [performing energization through the conductive substrate 2 convenient, and] the bonding strength of the metal layer 3 and the conductive substrate 2, it is desirable to adopt the structure where the conductive substrate 2 and the metal layer 3 were contacted directly.

[0012] The first electrode 5 can form a part of front face of the luminous layer section 4 in a wrap form. In this case, a part of light [at least] 14 which goes to the metal layer 3 side among the light 13 and 14 generated in the barrier layer of the luminous layer section 4 can be reflected in this metal layer 3, and that reflected light 15 can be made to leak from the field which is not covered with the first electrode 5 of a luminous layer section front face. Thereby much more good optical drawing effectiveness is realizable.

[0013] The above light emitting devices 1 can manufacture the conductive substrate 2 and the luminous layer section 4 superposition and by carrying out junction processing through the metal layer 3 in respect of a junction schedule.

[0014] Specifically, it can manufacture by the manufacture approach of this invention shown below. That is, the manufacture approach of this invention is characterized by performing junction down stream processing which joins the process to which epitaxial growth of the luminous layer section 4 is carried out, and the first Lord front face of the conductive substrate 2 and the first Lord front face of the luminous layer section 4 only through the metal layer 3 on a semi-conductor single crystal substrate, and the process which separates or removes said semi-conductor single crystal substrate in this order. Junction processing can be considered as the junction processing by heating.

[0015] In the above-mentioned approach, the conductive substrate 2 and the luminous layer section 4 are joined only through the metal layer 3. It not only can raise bonding strength, but the electric switch-on between the conductive substrate 2 and the metal layer 3 is securable good by joining the conductive substrate 2 and the luminous layer section 4 only in the metal layer 3, without minding the insulating coat of SiO₂ grade unlike the aforementioned reference. If it is made to join in the form where a substrate and a part of metal layer are made to alloy especially when the conductive substrate 2 is a silicon single crystal, a compound semiconductor single crystal, or mixed crystal, bonding strength can be raised further.

[0016]

[Embodiment of the Invention] The gestalt of operation of this invention is explained using an attached drawing. Drawing 1 (a) is the conceptual diagram showing the light emitting device 1 which is 1 operation gestalt of this invention. The metal layer 3, the luminous layer section 4, and the first electrode 5 are formed in the light emitting device 1 in this sequence at the first Lord front-face 7 side of the conductive substrate 2. The first electrode 5 is formed in the wrap form in a part of front face of the luminous layer section 4. the [moreover, / of the conductive substrate 2] -- the second electrode 6 is formed in the 2 main front-face 8 side, and energization to the luminous layer (namely, first electrode 5 and conductive substrate 2 -- leading) section 4 is performed between the first electrode 5 and the second electrode 6 on both sides of the luminous layer section 4 and the metal layer 3.

[0017] Drawing 2 shows the more concrete configuration of a light emitting device 1. The conductive substrate 2 is used as an n mold Si (silicon) single crystal substrate, and the metal layer 3 contains the first metal layer 31 formed in contact with Si single crystal substrate 2, the middle metal layer 32 which touches this first metal layer 31 at the luminous layer section 4 side, and the second metal layer 33 formed in contact with the luminous layer section 4. Also in case Si single crystal substrate 2 performs heating junction mentioned later, in order that it cannot produce deformation by thermal stress etc. easily and may tend to alloy it with some specific metals (for example, Au), it has the advantage which is easy to realize strong high junction structure. In this case, by using as a principal component the metal component which is easy to alloy this first metal layer 31 with Si rather than the metal component used as the principal component of the middle metal layer 32, and forming it, alloying with the metal layer 3 and Si single crystal substrate 2 is mainly stopped in the first metal layer 31, and it becomes possible to

control attaining to the middle metal layer 32. Thereby, the rate of area of the metal phase in the junction interface of the metal layer 3 and the luminous layer section 4 is raised, and the surface smoothness of a junction interface can be kept good. All contribute to improvement in the reflection factor in a junction interface.

[0018] In this case, the first metal layer 31 can form a metal component with eutectic temperature lower than the metal component used as the principal component of the middle metal layer 32 with Si in a principal component. Degradation of the luminous layer section 4 etc. can be made hard to be able to low-temperature-ize heating virtual junction temperature by using as the principal component of the first metal layer 31 the component which forms an eutectic at low temperature comparatively between silicon with the high melting point, as a result to produce. As a concrete example, the first metal layer 31 can constitute Au for Au layer or an AuGe alloy (for example, thing whose germanium content is about 12 % of the weight) layer in a principal component, and the middle metal layer 32 can constitute aluminum, such as aluminum layer or aluminum alloy layer, in a principal component. The eutectic temperature of Au and Si is about 363 degrees C, and the eutectic temperature of aluminum and Si is about 577 degrees C. In addition, as for the middle metal layer 32, it is desirable between Au(s) to constitute the metal which, if possible, does not form an eutectic with the low melting point in a principal component in the viewpoint of the middle metal layer 32 and Si single crystal substrate 2 which make it hard to attain to the middle metal layer 32 in the effect of alloying. aluminum is desirable as a principal component of the middle metal layer 32 in this viewpoint. Moreover, except aluminum, components, such as Ag, Cu, nickel, Pd, or Pt, are also employable.

[0019] In addition, in order to raise the metal layer 3 and ohmic contact nature with the second electrode 6, as for Si single crystal substrate 2, it is desirable to adopt what formed high concentration dope layer 2a in the first principal plane and second principal plane side (for example, double-sided diffusion wafer to which thermal diffusion of the high-concentration dopant was carried out). Or it is possible to use what doped As and B to high concentration as an Si single crystal substrate 2. With this operation gestalt, the n mold Si single crystal substrate 2 in which n+ dope layer 2a was formed to both sides is used.

[0020] Next, with this operation gestalt, between the middle metal layer 32 and the luminous layer section 4, while touching the n mold AlGaInP cladding layer 41, the second metal layer 33 which reflects the light from the luminous layer section 4 is formed.

[0021] What is constituted by the subject in Au can be illustrated as the quality of the material of said second metal layer 33. With this operation gestalt, the second metal layer 33 is formed with the Au-germanium alloy. germanium content in the Au-germanium alloy to be used is good to consider as one to 3 mass %. Moreover, the second metal layer 33 can also be used as Au layer.

[0022] Next, the luminous layer section 4 shall have a terrorism structure layer to the double which consists of the first conductivity-type cladding layer 43 located in the first electrode 5 side, the second conductivity-type cladding layer 41 located in the metal layer 3 side, and a barrier layer 42 formed between the first conductivity-type cladding layer 43 and the second conductivity-type cladding layer 41. Since the hole and electron which were poured in from both the cladding layers 43 and 41 by adopting such structure shut up in the narrow space of a barrier layer 42 and recombine efficiently with a **** form, the component of high brightness is realizable. In addition, in order to raise the optical drawing effectiveness by reflection, the second conductivity-type cladding layer 41 and the metal layer 3 are good to be formed directly. However, in order to lower operating voltage, it is also possible to insert the thin film of a high concentration dope between the second conductivity-type cladding layer 41 and the metal layer 3.

[0023] A terrorism structure layer can specifically consist of AlGaInP mixed crystal to double. Specifically, the barrier layer 42 which consists of AlGaInP mixed crystal or GaInP mixed crystal can be made into the structure inserted by the p mold AlGaInP cladding layer 43 and the n mold AlGaInP cladding layer 41. AlGaInP is a semi-conductor which has a big band gap with a direct transition mold, and since the hole and electron which were poured in are shut up into the narrow barrier layer 42 and recombine efficiently with the energy barrier resulting from a band gap difference with the cladding

layers 43 and 41 formed in the both sides of a barrier layer 42, very high luminous efficiency is realizable. Furthermore, by presentation adjustment of a barrier layer 42, it can apply to a red field from green, and wide range luminescence wavelength can be realized. In the light emitting device 1 of drawing 2, the p mold AlGaInP cladding layer 43 is arranged at the first electrode 5 side, and the first electrode 5 side of an energization polarity is forward.

[0024] Next, between the first electrode 5 and the first conductivity-type cladding layer 43, the current diffusion layer 44 of the same conductivity type as this first conductivity-type cladding layer 43 is formed. the field which it becomes possible [diffusing a current] as the first electrode 5 becomes homogeneity to the terrorism structure layers 41, 42, and 43 at field inboard to double by forming the current diffusion layer 44, since a part of front face of the luminous layer section 4 is formed in the wrap form, and is not covered with the first electrode 5 -- also setting -- high -- a brightness luminescence condition can be acquired. Consequently, the reinforcement of the reflected light by the metal layer 3 also becomes strong from the first, and since the direct light in the field concerned can take out the light efficiently, without being further interfered by the first electrode 5, it can raise the luminescence brightness of the whole component sharply.

[0025] The current diffusion layer 44 can consist of AlGaAs mixed crystal or AlGaAsP mixed crystal. Since a lattice constant difference with GaAs is small and grid adjustment with a GaAs single crystal substrate is high, even if AlGaAs mixed crystal or AlGaAsP mixed crystal carries out epitaxial growth of the AlGaInP mixed crystal further on it, it has the advantage which is easy to maintain good adjustment. With the operation gestalt of drawing 2, the current diffusion layer 44 is formed in high concentration with the p+ mold AlGaAsP mixed crystal which doped the impurity.

[0026] In addition, the 31= 200nm of the :first metal layers which can illustrate the following numeric values as an example of the thickness of each class in the light emitting device 1 of drawing 2, 32= 100nm of middle metal layers, the 33= 200nm of the second metal layers, 41= 1000nm of n mold AlGaInP cladding layers, 42= 600nm of AlGaInP barrier layers, 41= 1000nm of p mold AlGaInP cladding layers, 44= 1000nm of p+ mold AlGaAsP current diffusion layers. Moreover, for example, Au layer and an AuBe layer can constitute the first electrode 5, nickel layer can constitute the second electrode 6, and thickness can be set to about 1000nm, respectively.

[0027] Hereafter, the manufacture approach of the light emitting device 1 of drawing 1 is explained. First, the first Lord front face 81 of the GaAs single crystal substrate 61 which is a semi-conductor single crystal substrate is made to carry out epitaxial growth of the p+ mold AlGaAsP current diffusion layer 44, the p mold AlGaInP cladding layer 43, the AlGaInP barrier layer 42, and the n mold AlGaInP cladding layer 41 to this sequence as the luminous layer section 4, as shown in drawing 3 (a). the epitaxial growth of these each class -- organic metal vapor phase epitaxial growth (Metalorganic Vapor Phase Epitaxy:MOVPE) -- it can carry out by law.

[0028] Next, as shown in drawing 3 (b), the AuGe layer (the second metal layer) 33, the aluminum layer (middle metal layer) 32, and the Au layer (the first metal layer) 31 are formed in this sequence as a metal layer 3 on the n mold AlGaInP cladding layer 41 of the luminous layer section 4. Formation of each class can be performed with well-known physical vapor deposition, such as a vacuum deposition method or a spatter. And junction processing is performed by heating the metal layer 3 side of the multilayer substrate 63 which did in this way and formed the metal layer 3 at superposition (drawing 3 (c)) and 300 degrees C - 500 degrees C to the first Lord front face 7 of Si single crystal substrate 2. Heating is performed for example, in nitrogen-gas-atmosphere mind. Thereby, the Au layer 31 is joined to the main front face 7 of Si single crystal substrate 2. It is more desirable to perform junction processing right above [of for example, Au-Si eutectic temperature] (for example, before or after 370 degrees C - 400 degrees C).

[0029] In the above-mentioned junction processing temperature, in case a part or the whole of the Au layer 31 is junction, an eutectic reaction is carried out to Si of Si single crystal substrate 2, and it becomes an Au-Si alloy layer. The presentation of the Au-Si alloy layer formed is Au-2 - 6 mass %Si. On the other hand, although aluminum which constitutes the aluminum layer 32 generates the intermetallic compound of various presentations between Au(s), in order that all these intermetallic

compounds may generate the liquid phase by the eutectic reaction at 300 degrees C - 500 degrees C which is virtual junction temperature, the alloying between aluminum is a pile to a lifting comparatively. Consequently, the effect of alloying with the Au layer 31 at the time of junction processing and Si stops easily being able to attain to the Au-germanium layer 33 which makes the second metal layer, and can raise the light reflex ability of the Au-germanium layer 33.

[0030] If junction processing is completed, as shown in drawing 3 (d), light emitting device substrate 1a of multilayer structure will be obtained by removing the GaAs single crystal substrate 61. For example, chemical etching can perform removal of the GaAs single crystal substrate 61. On the other hand, as shown in drawing 5 (a), the growth phase 62 for separation is beforehand formed between the luminous layer section 4 and the GaAs single crystal substrate 61 as a semi-conductor single crystal substrate. As shown in (b), after joining the luminous layer section 4 to Si single crystal substrate 2 which is a conductive substrate through the metal layer 3, you may make it separate the luminous layer section 4 and the GaAs single crystal substrate 61 by removing the growth phase 62 for separation alternatively, as shown in (c). In this case, the growth phase 62 for separation has the desirable thing [grow / and / it / on the GaAs single crystal substrate 61] constituted from the soluble high quality of the material over a specific etching reagent rather than the luminous layer section 4.

[0031] For example, when the current diffusion layer 44 consists of AlGaAs mixed crystal, the growth phase 62 for separation can consist of AlAs single crystal layers. In this case, it is good to use a sulfuric acid/hydrogen peroxide solution ($\text{H}_2\text{SO}_4/\text{H}_2\text{O}_2/\text{H}_2\text{O}$) as an etching reagent. Although there is almost corrosive [no / over the AlGaInP mixed crystal which makes the terrorism structure layers 41, 42, and 43 to the AlGaAs mixed crystal or double this etching reagent makes the current diffusion layer 44], to an AlAs single crystal layer, it has corrosive [remarkable]. Therefore, by immersing the multilayer junction substrate 67 formed including the growth phase 62 for separation in this etching reagent, the growth phase 62 for separation is dissolved and removed alternatively, and can separate the GaAs single crystal substrate 61 easily.

[0032] Light emitting device substrate 1a which removed thru/or separated the GaAs single crystal substrate 61 forms the first electrode 5 in the current diffusion layer 44 side, forms the second electrode 6 in the second Lord front-face 8 side of Si single crystal substrate 2, respectively, the semiconductor chip is fixed to a base material after dicing, and when wirebonding of the lead wire is carried out and it carries out a resin seal further, the light emitting device 1 shown in drawing 2 is obtained.

[0033] In the gestalt of operation shown in drawing 3, junction processing was performed in the form which joins the metal layer 3 formed in contact with the first Lord front-face side of the luminous layer section 4 to the first Lord front face 7 of the conductive substrate 2. On the other hand, junction processing may be performed in the form which joins the metal layer 3 formed in contact with the first Lord front face 7 of the conductive substrate 2 to the first Lord front-face 82 side of the luminous layer section 4, as shown in drawing 4 (a). With the gestalt of this operation, laminating formation of the Au layer 31, the aluminum layer 32, and the AuGe layer 33 is carried out in this sequence as a metal layer 3 on the first Lord front face 7 of Si single crystal substrate 2, and it is made to perform junction processing by contacting that metal layer 3 on the first Lord front face 82 of the luminous layer section 4 directly, and heating.

[0034] Furthermore, junction processing can also be performed in the form which joins the metal layers 32 and 33 formed in contact with the first Lord front face 82 of the luminous layer section 4 to the metal layer 31 formed in contact with the first Lord front face 7 of Si single crystal substrate 2 which is a conductive substrate, as shown in drawing 4 (b). With the operation gestalt shown in drawing, the junction interface is made to be formed between the aluminum layer 32 which turns into an interlayer, and the Au layer 31 used as the first metal layer. For example, in junction processing temperature, Au of the Au layer 31 is made to react with Si of Si single crystal substrate 2, eutectic melt is generated, and a good junction condition can be acquired by getting wet with the aluminum layer 32 and contacting the eutectic melt.

[0035] In addition, as shown in drawing 6 and drawing 7, various deformation can be added to the configuration of the metal layer 3. In the light emitting device 200 of drawing 6, the metal layer 3 is

formed only of the Au layer 33. However, a part of the Au layer 33 serves as an Au-Si alloy at least. Moreover, the light emitting device 210 of drawing 7 is the example which formed the metal layer 3 by two-layer [of the AuGe alloy layer 33 located in the luminous layer section 4 side, and the Au layer 31 located in Si single crystal substrate 2 side]. In any case, it is desirable to perform junction processing in the form where processing temperature is low set up a little near the eutectic temperature of Si-Au or rather than it.

[0036] Moreover, although the light emitting device 1,200,210 of drawing 2 , drawing 6 , and drawing 7 showed the example each of first conductivity-type cladding layers and whose current diffusion layers is p molds, as shown in drawing 11 , the configuration which uses the first conductivity-type cladding layer and a current diffusion layer as n mold is also possible. In this light emitting device 230, the Au layer (the first metal layer) 31, the aluminum layer (middle metal layer) 32, and AuBe layer (second metal layer) 33' are formed in this sequence as metal layer 3' on the first Lord front face 7 of Si single crystal substrate 2. moreover -- as luminous layer section 4' -- the metal layer 3 -- 'the p mold AlGaInP cladding layer 43 from a side, the AlGaInP barrier layer 42, the n mold AlGaInP cladding layer 41, and the n+ mold AlGaAs current diffusion layer 44' are formed. The built-up sequence of the layers 41, 42, and 43 of this light emitting device 230 is completely contrary to the light emitting device 1 of drawing 1 , and the first electrode 5 side of an energization polarity is negative.

[0037] The advantage by adopting this structure is as follows. That is, as shown in drawing 9 , when what carried out epitaxial growth of the luminous layer section 4 on the GaAs single crystal substrate 61 is joined to Si single crystal substrate 2 through the metal layer 3 and the GaAs single crystal substrate 61 is removed after that, as shown in drawing 9 (b), curvature may arise in the light emitting device substrate obtained. The cause which this curvature produces is as follows. That is, as shown in drawing 10 , in the AlGaAs current diffusion layer 44 which carried out epitaxial growth on the GaAs single crystal substrate 61, the elastic adjustment distortion for carrying out lattice matching to the GaAs single crystal substrate 61 has arisen. Since the lattice constant of AlAs being somewhat larger than the lattice constant of GaAs, speaking concretely, will be arisen by the elastic strain of the compression direction within a field in the AlGaAs current diffusion layer 44 side. And when the GaAs single crystal substrate 61 is removed, the elastic strain of the AlGaAs current diffusion layer 44 is released in the form elongated to field inboard, as a result, as shown in drawing 9 (b), it is the form where the AlGaAs current diffusion layer 44 side serves as a convex, and curvature will generate it in a light emitting device substrate. It introduces [a crack] into a luminous layer and is not desirable if such curvature occurs.

[0038] By the way, current spreading effect with the current diffusion layer 44 sufficient by thickness with few n molds with which a majority carrier serves as an electron than the thing of p mold with which the hole where an effective mass is large serves as a majority carrier generally is acquired. Therefore, as shown in drawing 10 (b), the way of the thing (44') of n mold can make thinner than the thing (44) of p mold shown in (a) the AlGaAs current diffusion layer which carries out epitaxial growth to the GaAs single crystal substrate 61. If the thickness of an AlGaAs current diffusion layer becomes small, the elastic strain energy released when the GaAs single crystal substrate 61 is removed also becomes small, and can also make small the curvature of the substrate which appears as work to which the released energy carries out. That is, as shown in drawing 11 , the curvature produced in a light emitting device substrate is mitigable by adopting the structure which uses the first conductivity-type cladding layer and a current diffusion layer as n mold.

[0039] In addition, the thickness of current diffusion layer 44' it is thin from the AlGaAs mixed crystal or AlGaAsP mixed crystal of n+ mold doped to high concentration is good to be referred to as 10nm - 1000nm. Moreover, the thickness of each class other than this can adopt the same thing as the light emitting device 1 of drawing 2 .

[0040] In addition, the current spreading effect in the heterojunction interface in the luminous layer section 4 can be heightened by choosing the presentation of the current diffusion layer 44 appropriately, and enlarging the amount of band discontinuity with the cladding layer which this current diffusion layer 44 touches. In this case, it is effective, when it also becomes possible to make thickness of the current

diffusion layer 44 small and curvature prevention of the light emitting device substrate obtained is aimed at.

[0041] Next, as shown in drawing 8, it is also possible to replace a conductive substrate with semi-conductors, such as Si single crystal, and to use a metal. In the light emitting device 220 shown in drawing 8, the aluminum substrate 21 is used as a conductive substrate 2. As a metal layer 3, the thing of the two-layer structure which has arranged the Au layer 31 to the aluminum substrate 21 side, and has arranged the Au-germanium alloy layer 33 to the luminous layer section 4 side is adopted. It becomes possible to omit the second electrode by using a metal for the conductive substrate 2. In addition, as the quality of the material of the metal used as a conductive substrate 2, it is also possible to use Sn in addition to aluminum.

[0042] In addition, with the operation gestalt shown in drawing 4 - drawing 11, although the current diffusion layer is formed with AlGaAs mixed crystal, AlGaAsP mixed crystal may be used like drawing 2.

[0043] Moreover, although the conductive substrate 2 constituted Si single crystal or the metal from a gestalt of the operation explained above with the quality of the material which does not have translucency substantially, it is also possible to form with the quality of the material which has translucency like the light emitting device 240 shown in drawing 12. In this case, the optical passage section 141 can be formed in the metal layer 3. By doing in this way, contribution of the both sides of the reflected light by the metal layer 3 and the transmitted light which carried out incidence to the conductive substrate 22 side of translucency through the optical passage section 141 can raise optical drawing effectiveness now. In this case, if the second Lord front face 8 of the conductive substrate 22 of translucency is covered with the second metal electrode 6, the contribution to the improvement in optical drawing effectiveness by the reflected light in the front face of the second electrode 6 is also expectable. As a conductive substrate 22 of translucency, a GaP substrate can be used, for example. Moreover, the laminated structure of the luminous layer section 4 and the metal layer 3 can adopt the same thing as drawing 2, drawing 7, drawing 11, etc. as the metal layer 3 except for the point which forms the optical passage section 141.

[0044] Moreover, in order to form the optical passage section 141 in the metal layer 3, the approach of carrying out patterning of the metal layer 3 with masking etc. is employable at the time of the stratification. For example, as shown in drawing 13 (a), pattern NINGU of the metal layer 3 can be carried out at a line, and the optical passage section 141 can be formed in the shape of a slit between adjoining linear metal layer fields. Moreover, as shown in drawing 13 (b), pattern NINGU of the metal layer 3 can be carried out reticulated, and the mesh can also be made into the optical passage section 141. Furthermore, if pattern NINGU of the metal layer 3 is carried out at the letter of dispersion, or island shape as shown in drawing 13 (c), a part for the background of each metal layer field is utilizable as the optical passage section 141.

[Translation done.]



* NOTICES *

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
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3. In the drawings, any words are not translated.

EFFECT OF THE INVENTION

[Means for Solving the Problem and its Function and Effect] In order to solve the above-mentioned technical problem, a metal layer, the luminous layer section, and the first electrode are formed in the first Lord front-face side of a conductive substrate in this sequence, and the light emitting device of this invention is characterized by the energization to the luminous layer section being possible through the first electrode and a conductive substrate.

[0009] According to the above-mentioned structure, in addition to good optical drawing effectiveness being realizable, in the light emitting device which inserted the metal layer between a substrate and the luminous layer section, it becomes possible by using reflection in a metal layer to form an electrode or a terminal in the both sides of a light emitting device. It becomes unnecessary that is, to make it the complicated structure of unlike the light emitting device (drawing 14) of the above mentioned reference exposing a metal layer to the side of the luminous layer section, and forming a terminal takeoff connection. Therefore, while it is simplified sharply and the terminal drawing structure of a component can reduce a chip size, the light emitting device excellent in convenience is realized.

[0010] As shown in drawing 1 , the energization direction to the layered product 9 which consists of the conductive substrate 2, a metal layer 3, and the luminous layer section 4 is all possible also at the polarity from which the first electrode side serves as forward, as are shown in (a), and the polarity from which the first electrode side serves as negative also shows to (b). In this case, the built-up sequence of the heterojunction structure in the luminous layer section 4 becomes reverse at (a) and (b).

[0011] The conductive substrate 2 can also be used as semi-conductors, such as a silicon single crystal, and can also be used as metals, such as aluminum. When using the conductive substrate 2 as a semi-conductor, as shown in drawing 1 , the second electrode 6 is formed in the second Lord front-face side of the conductive substrate 2, and the second terminal 12 is further formed in this second electrode 6. In this case, it becomes the form where energization is made between the first electrode 5 and the second electrode 6. On the other hand, since the direct formation of the second terminal 12 can be carried out at the conductive substrate 2 when using the conductive substrate 2 as a metal, the second electrode 6 can also be omitted. In addition, when adopting a semi-conductor as a conductive substrate 2, in two viewpoints, raise [performing energization through the conductive substrate 2 convenient, and] the bonding strength of the metal layer 3 and the conductive substrate 2, it is desirable to adopt the structure where the conductive substrate 2 and the metal layer 3 were contacted directly.

[0012] The first electrode 5 can form a part of front face of the luminous layer section 4 in a wrap form. In this case, a part of light [at least] 14 which goes to the metal layer 3 side among the light 13 and 14 generated in the barrier layer of the luminous layer section 4 can be reflected in this metal layer 3, and that reflected light 15 can be made to leak from the field which is not covered with the first electrode 5 of a luminous layer section front face. Thereby much more good optical drawing effectiveness is realizable.

[0013] The above light emitting devices 1 can manufacture the conductive substrate 2 and the luminous layer section 4 superposition and by carrying out junction processing through the metal layer 3 in respect of a junction schedule.

[0014] Specifically, it can manufacture by the manufacture approach of this invention shown below. That is, the manufacture approach of this invention is characterized by performing junction down stream processing which joins the process to which epitaxial growth of the luminous layer section 4 is carried out, and the first Lord front face of the conductive substrate 2 and the first Lord front face of the luminous layer section 4 only through the metal layer 3 on a semi-conductor single crystal substrate, and the process which separates or removes said semi-conductor single crystal substrate in this order. Junction processing can be considered as the junction processing by heating.

[0015] In the above-mentioned approach, the conductive substrate 2 and the luminous layer section 4 are joined only through the metal layer 3. It not only can raise bonding strength, but the electric switch-on between the conductive substrate 2 and the metal layer 3 is securable good by joining the conductive substrate 2 and the luminous layer section 4 only in the metal layer 3, without minding the insulating coat of SiO₂ grade unlike the aforementioned reference. If it is made to join in the form where a substrate and a part of metal layer are made to alloy especially when the conductive substrate 2 is a silicon single crystal, a compound semiconductor single crystal, or mixed crystal, bonding strength can be raised further.

[0016]

[Embodiment of the Invention] The gestalt of operation of this invention is explained using an attached drawing. Drawing 1 (a) is the conceptual diagram showing the light emitting device 1 which is 1 operation gestalt of this invention. The metal layer 3, the luminous layer section 4, and the first electrode 5 are formed in the light emitting device 1 in this sequence at the first Lord front-face 7 side of the conductive substrate 2. The first electrode 5 is formed in the wrap form in a part of front face of the luminous layer section 4. the [moreover, / of the conductive substrate 2] -- the second electrode 6 is formed in the 2 main front-face 8 side, and energization to the luminous layer (namely, first electrode 5 and conductive substrate 2 -- leading) section 4 is performed between the first electrode 5 and the second electrode 6 on both sides of the luminous layer section 4 and the metal layer 3.

[0017] Drawing 2 shows the more concrete configuration of a light emitting device 1. The conductive substrate 2 is used as an n mold Si (silicon) single crystal substrate, and the metal layer 3 contains the first metal layer 31 formed in contact with Si single crystal substrate 2, the middle metal layer 32 which touches this first metal layer 31 at the luminous layer section 4 side, and the second metal layer 33 formed in contact with the luminous layer section 4. Also in case Si single crystal substrate 2 performs heating junction mentioned later, in order that it cannot produce deformation by thermal stress etc. easily and may tend to alloy it with some specific metals (for example, Au), it has the advantage which is easy to realize strong high junction structure. In this case, by using as a principal component the metal component which is easy to alloy this first metal layer 31 with Si rather than the metal component used as the principal component of the middle metal layer 32, and forming it, alloying with the metal layer 3 and Si single crystal substrate 2 is mainly stopped in the first metal layer 31, and it becomes possible to control attaining to the middle metal layer 32. Thereby, the rate of area of the metal phase in the junction interface of the metal layer 3 and the luminous layer section 4 is raised, and the surface smoothness of a junction interface can be kept good. All contribute to improvement in the reflection factor in a junction interface.

[0018] In this case, the first metal layer 31 can form a metal component with eutectic temperature lower than the metal component used as the principal component of the middle metal layer 32 with Si in a principal component. Degradation of the luminous layer section 4 etc. can be made hard to be able to low-temperature-ize heating virtual junction temperature by using as the principal component of the first metal layer 31 the component which forms an eutectic at low temperature comparatively between silicon with the high melting point, as a result to produce. As a concrete example, the first metal layer 31 can constitute Au for Au layer or an AuGe alloy (for example, thing whose germanium content is about 12 % of the weight) layer in a principal component, and the middle metal layer 32 can constitute aluminum, such as aluminum layer or aluminum alloy layer, in a principal component. The eutectic temperature of Au and Si is about 363 degrees C, and the eutectic temperature of aluminum and Si is about 577 degrees C. In addition, as for the middle metal layer 32, it is desirable between Au(s) to constitute the metal

which, if possible, does not form an eutectic with the low melting point in a principal component in the viewpoint of the middle metal layer 32 and Si single crystal substrate 2 which make it hard to attain to the middle metal layer 32 in the effect of alloying. aluminum is desirable as a principal component of the middle metal layer 32 in this viewpoint. Moreover, except aluminum, components, such as Ag, Cu, nickel, Pd, or Pt, are also employable.

[0019] In addition, in order to raise the metal layer 3 and ohmic contact nature with the second electrode 6, as for Si single crystal substrate 2, it is desirable to adopt what formed high concentration dope layer 2a in the first principal plane and second principal plane side (for example, double-sided diffusion wafer to which thermal diffusion of the high-concentration dopant was carried out). Or it is possible to use what doped As and B to high concentration as an Si single crystal substrate 2. With this operation gestalt, the n mold Si single crystal substrate 2 in which n+ dope layer 2a was formed to both sides is used.

[0020] Next, with this operation gestalt, between the middle metal layer 32 and the luminous layer section 4, while touching the n mold AlGaInP cladding layer 41, the second metal layer 33 which reflects the light from the luminous layer section 4 is formed.

[0021] What is constituted by the subject in Au can be illustrated as the quality of the material of said second metal layer 33. With this operation gestalt, the second metal layer 33 is formed with the Au-germanium alloy. germanium content in the Au-germanium alloy to be used is good to consider as one to 3 mass %. Moreover, the second metal layer 33 can also be used as Au layer.

[0022] Next, the luminous layer section 4 shall have a terrorism structure layer to the double which consists of the first conductivity-type cladding layer 43 located in the first electrode 5 side, the second conductivity-type cladding layer 41 located in the metal layer 3 side, and a barrier layer 42 formed between the first conductivity-type cladding layer 43 and the second conductivity-type cladding layer 41. Since the hole and electron which were poured in from both the cladding layers 43 and 41 by adopting such structure shut up in the narrow space of a barrier layer 42 and recombine efficiently with a **** form, the component of high brightness is realizable. In addition, in order to raise the optical drawing effectiveness by reflection, the second conductivity-type cladding layer 41 and the metal layer 3 are good to be formed directly. However, in order to lower operating voltage, it is also possible to insert the thin film of a high concentration dope between the second conductivity-type cladding layer 41 and the metal layer 3.

[0023] A terrorism structure layer can specifically consist of AlGaInP mixed crystal to double. Specifically, the barrier layer 42 which consists of AlGaInP mixed crystal or GaInP mixed crystal can be made into the structure inserted by the p mold AlGaInP cladding layer 43 and the n mold AlGaInP cladding layer 41. AlGaInP is a semi-conductor which has a big band gap with a direct transition mold, and since the hole and electron which were poured in are shut up into the narrow barrier layer 42 and recombine efficiently with the energy barrier resulting from a band gap difference with the cladding layers 43 and 41 formed in the both sides of a barrier layer 42, very high luminous efficiency is realizable. Furthermore, by presentation adjustment of a barrier layer 42, it can apply to a red field from green, and wide range luminescence wavelength can be realized. In the light emitting device 1 of drawing 2, the p mold AlGaInP cladding layer 43 is arranged at the first electrode 5 side, and the first electrode 5 side of an energization polarity is forward.

[0024] Next, between the first electrode 5 and the first conductivity-type cladding layer 43, the current diffusion layer 44 of the same conductivity type as this first conductivity-type cladding layer 43 is formed. the field which it becomes possible [diffusing a current] as the first electrode 5 becomes homogeneity to the terrorism structure layers 41, 42, and 43 at field inboard to double by forming the current diffusion layer 44, since a part of front face of the luminous layer section 4 is formed in the wrap form, and is not covered with the first electrode 5 -- also setting -- high -- a brightness luminescence condition can be acquired. Consequently, the reinforcement of the reflected light by the metal layer 3 also becomes strong from the first, and since the direct light in the field concerned can take out the light efficiently, without being further interfered by the first electrode 5, it can raise the luminescence brightness of the whole component sharply.

[0025] The current diffusion layer 44 can consist of AlGaAs mixed crystal or AlGaAsP mixed crystal. Since a lattice constant difference with GaAs is small and grid adjustment with a GaAs single crystal substrate is high, even if AlGaAs mixed crystal or AlGaAsP mixed crystal carries out epitaxial growth of the AlGaInP mixed crystal further on it, it has the advantage which is easy to maintain good adjustment. With the operation gestalt of drawing 2, the current diffusion layer 44 is formed in high concentration with the p⁺ mold AlGaAsP mixed crystal which doped the impurity.

[0026] In addition, the 31= 200nm of the first metal layers which can illustrate the following numeric values as an example of the thickness of each class in the light emitting device 1 of drawing 2, 32= 100nm of middle metal layers, the 33= 200nm of the second metal layers, 41= 1000nm of n mold AlGaInP cladding layers, 42= 600nm of AlGaInP barrier layers, 41= 1000nm of p mold AlGaInP cladding layers, 44= 1000nm of p⁺ mold AlGaAsP current diffusion layers. Moreover, for example, Au layer and an AuBe layer can constitute the first electrode 5, nickel layer can constitute the second electrode 6, and thickness can be set to about 1000nm, respectively.

[0027] Hereafter, the manufacture approach of the light emitting device 1 of drawing 1 is explained. First, the first Lord front face 81 of the GaAs single crystal substrate 61 which is a semi-conductor single crystal substrate is made to carry out epitaxial growth of the p⁺ mold AlGaAsP current diffusion layer 44, the p mold AlGaInP cladding layer 43, the AlGaInP barrier layer 42, and the n mold AlGaInP cladding layer 41 to this sequence as the luminous layer section 4, as shown in drawing 3 (a). the epitaxial growth of these each class -- organic metal vapor phase epitaxial growth (Metalorganic Vapor Phase Epitaxy:MOVPE) -- it can carry out by law.

[0028] Next, as shown in drawing 3 (b), the AuGe layer (the second metal layer) 33, the aluminum layer (middle metal layer) 32, and the Au layer (the first metal layer) 31 are formed in this sequence as a metal layer 3 on the n mold AlGaInP cladding layer 41 of the luminous layer section 4. Formation of each class can be performed with well-known physical vapor deposition, such as a vacuum deposition method or a spatter. And junction processing is performed by heating the metal layer 3 side of the multilayer substrate 63 which did in this way and formed the metal layer 3 at superposition (drawing 3 (c)) and 300 degrees C - 500 degrees C to the first Lord front-face 7 of Si single crystal substrate 2. Heating is performed for example, in nitrogen-gas-atmosphere mind. Thereby, the Au layer 31 is joined to the main front face 7 of Si single crystal substrate 2. It is more desirable to perform junction processing right above [of for example, Au-Si eutectic temperature] (for example, before or after 370 degrees C - 400 degrees C).

[0029] In the above-mentioned junction processing temperature, in case a part or the whole of the Au layer 31 is junction, an eutectic reaction is carried out to Si of Si single crystal substrate 2, and it becomes an Au-Si alloy layer. The presentation of the Au-Si alloy layer formed is Au-2 - 6 mass %Si. On the other hand, although aluminum which constitutes the aluminum layer 32 generates the intermetallic compound of various presentations between Au(s), in order that all these intermetallic compounds may generate the liquid phase by the eutectic reaction at 300 degrees C - 500 degrees C which is virtual junction temperature, the alloying between aluminum is a pile to a lifting comparatively. Consequently, the effect of alloying with the Au layer 31 at the time of junction processing and Si stops easily being able to attain to the Au-germanium layer 33 which makes the second metal layer, and can raise the light reflex ability of the Au-germanium layer 33.

[0030] If junction processing is completed, as shown in drawing 3 (d), light emitting device substrate 1a of multilayer structure will be obtained by removing the GaAs single crystal substrate 61. For example, chemical etching can perform removal of the GaAs single crystal substrate 61. On the other hand, as shown in drawing 5 (a), the growth phase 62 for separation is beforehand formed between the luminous layer section 4 and the GaAs single crystal substrate 61 as a semi-conductor single crystal substrate. As shown in (b), after joining the luminous layer section 4 to Si single crystal substrate 2 which is a conductive substrate through the metal layer 3, you may make it separate the luminous layer section 4 and the GaAs single crystal substrate 61 by removing the growth phase 62 for separation alternatively, as shown in (c). In this case, the growth phase 62 for separation has the desirable thing [grow / and / it / on the GaAs single crystal substrate 61] constituted from the soluble high quality of the material over a

specific etching reagent rather than the luminous layer section 4.

[0031] For example, when the current diffusion layer 44 consists of AlGaAs mixed crystal, the growth phase 62 for separation can consist of AlAs single crystal layers. In this case, it is good to use a sulfuric acid/hydrogen peroxide solution ($\text{H}_2\text{SO}_4/\text{H}_2\text{O}_2/\text{H}_2\text{O}$) as an etching reagent. Although there is almost corrosive [no / over the AlGaInP mixed crystal which makes the terrorism structure layers 41, 42, and 43 to the AlGaAs mixed crystal or double this etching reagent makes the current diffusion layer 44], to an AlAs single crystal layer, it has corrosive [remarkable]. Therefore, by immersing the multilayer junction substrate 67 formed including the growth phase 62 for separation in this etching reagent, the growth phase 62 for separation is dissolved and removed alternatively, and can separate the GaAs single crystal substrate 61 easily.

[0032] Light emitting device substrate 1a which removed thru/or separated the GaAs single crystal substrate 61 forms the first electrode 5 in the current diffusion layer 44 side, forms the second electrode 6 in the second Lord front-face 8 side of Si single crystal substrate 2, respectively, the semiconductor chip is fixed to a base material after dicing, and when wirebonding of the lead wire is carried out and it carries out a resin seal further, the light emitting device 1 shown in drawing 2 is obtained.

[0033] In the gestalt of operation shown in drawing 3, junction processing was performed in the form which joins the metal layer 3 formed in contact with the first Lord front-face side of the luminous layer section 4 to the first Lord front face 7 of the conductive substrate 2. On the other hand, junction processing may be performed in the form which joins the metal layer 3 formed in contact with the first Lord front face 7 of the conductive substrate 2 to the first Lord front-face 82 side of the luminous layer section 4, as shown in drawing 4 (a). With the gestalt of this operation, laminating formation of the Au layer 31, the aluminum layer 32, and the AuGe layer 33 is carried out in this sequence as a metal layer 3 on the first Lord front face 7 of Si single crystal substrate 2, and it is made to perform junction processing by contacting that metal layer 3 on the first Lord front face 82 of the luminous layer section 4 directly, and heating.

[0034] Furthermore, junction processing can also be performed in the form which joins the metal layers 32 and 33 formed in contact with the first Lord front face 82 of the luminous layer section 4 to the metal layer 31 formed in contact with the first Lord front face 7 of Si single crystal substrate 2 which is a conductive substrate, as shown in drawing 4 (b). With the operation gestalt shown in drawing, the junction interface is made to be formed between the aluminum layer 32 which turns into an interlayer, and the Au layer 31 used as the first metal layer. For example, in junction processing temperature, Au of the Au layer 31 is made to react with Si of Si single crystal substrate 2, eutectic melt is generated, and a good junction condition can be acquired by getting wet with the aluminum layer 32 and contacting the eutectic melt.

[0035] In addition, as shown in drawing 6 and drawing 7, various deformation can be added to the configuration of the metal layer 3. In the light emitting device 200 of drawing 6, the metal layer 3 is formed only of the Au layer 33. However, a part of the Au layer 33 serves as an Au-Si alloy at least. Moreover, the light emitting device 210 of drawing 7 is the example which formed the metal layer 3 by two-layer [of the AuGe alloy layer 33 located in the luminous layer section 4 side, and the Au layer 31 located in Si single crystal substrate 2 side]. In any case, it is desirable to perform junction processing in the form where processing temperature is low set up a little near the eutectic temperature of Si-Au or rather than it.

[0036] Moreover, although the light emitting device 1,200,210 of drawing 2, drawing 6, and drawing 7 showed the example each of first conductivity-type cladding layers and whose current diffusion layers is p molds, as shown in drawing 11, the configuration which uses the first conductivity-type cladding layer and a current diffusion layer as n mold is also possible. In this light emitting device 230, the Au layer (the first metal layer) 31, the aluminum layer (middle metal layer) 32, and AuBe layer (second metal layer) 33' are formed in this sequence as metal layer 3' on the first Lord front face 7 of Si single crystal substrate 2. moreover -- as luminous layer section 4' -- the metal layer 3 -- 'the p mold AlGaInP cladding layer 43 from a side, the AlGaInP barrier layer 42, the n mold AlGaInP cladding layer 41, and the n+ mold AlGaAs current diffusion layer 44' are formed. The built-up sequence of the layers 41, 42,

and 43 of this light emitting device 230 is completely contrary to the light emitting device 1 of drawing 1, and the first electrode 5 side of an energization polarity is negative.

[0037] The advantage by adopting this structure is as follows. That is, as shown in drawing 9, when what carried out epitaxial growth of the luminous layer section 4 on the GaAs single crystal substrate 61 is joined to Si single crystal substrate 2 through the metal layer 3 and the GaAs single crystal substrate 61 is removed after that, as shown in drawing 9 (b), curvature may arise in the light emitting device substrate obtained. The cause which this curvature produces is as follows. That is, as shown in drawing 10, in the AlGaAs current diffusion layer 44 which carried out epitaxial growth on the GaAs single crystal substrate 61, the elastic adjustment distortion for carrying out lattice matching to the GaAs single crystal substrate 61 has arisen. Since the lattice constant of AlAs being somewhat larger than the lattice constant of GaAs, speaking concretely, will be arisen by the elastic strain of the compression direction within a field in the AlGaAs current diffusion layer 44 side. And when the GaAs single crystal substrate 61 is removed, the elastic strain of the AlGaAs current diffusion layer 44 is released in the form elongated to field inboard, as a result, as shown in drawing 9 (b), it is the form where the AlGaAs current diffusion layer 44 side serves as a convex, and curvature will generate it in a light emitting device substrate. It introduces [a crack] into a luminous layer and is not desirable if such curvature occurs.

[0038] By the way, current spreading effect with the current diffusion layer 44 sufficient by thickness with few n molds with which a majority carrier serves as an electron than the thing of p mold with which the hole where an effective mass is large serves as a majority carrier generally is acquired. Therefore, as shown in drawing 10 (b), the way of the thing (44') of n mold can make thinner than the thing (44) of p mold shown in (a) the AlGaAs current diffusion layer which carries out epitaxial growth to the GaAs single crystal substrate 61. If the thickness of an AlGaAs current diffusion layer becomes small, the elastic strain energy released when the GaAs single crystal substrate 61 is removed also becomes small, and can also make small the curvature of the substrate which appears as work to which the released energy carries out. That is, as shown in drawing 11, the curvature produced in a light emitting device substrate is mitigable by adopting the structure which uses the first conductivity-type cladding layer and a current diffusion layer as n mold.

[0039] In addition, the thickness of current diffusion layer 44' it is thin from the AlGaAs mixed crystal or AlGaAsP mixed crystal of n+ mold doped to high concentration is good to be referred to as 10nm - 1000nm. Moreover, the thickness of each class other than this can adopt the same thing as the light emitting device 1 of drawing 2.

[0040] In addition, the current spreading effect in the heterojunction interface in the luminous layer section 4 can be heightened by choosing the presentation of the current diffusion layer 44 appropriately, and enlarging the amount of band discontinuity with the cladding layer which this current diffusion layer 44 touches. In this case, it is effective, when it also becomes possible to make thickness of the current diffusion layer 44 small and curvature prevention of the light emitting device substrate obtained is aimed at.

[0041] Next, as shown in drawing 8, it is also possible to replace a conductive substrate with semiconductors, such as Si single crystal, and to use a metal. In the light emitting device 220 shown in drawing 8, the aluminum substrate 21 is used as a conductive substrate 2. As a metal layer 3, the thing of the two-layer structure which has arranged the Au layer 31 to the aluminum substrate 21 side, and has arranged the Au-germanium alloy layer 33 to the luminous layer section 4 side is adopted. It becomes possible to omit the second electrode by using a metal for the conductive substrate 2. In addition, as the quality of the material of the metal used as a conductive substrate 2, it is also possible to use Sn in addition to aluminum.

[0042] In addition, with the operation gestalt shown in drawing 4 - drawing 11, although the current diffusion layer is formed with AlGaAs mixed crystal, AlGaAsP mixed crystal may be used like drawing 2.

[0043] Moreover, although the conductive substrate 2 constituted Si single crystal or the metal from a gestalt of the operation explained above with the quality of the material which does not have

translucency substantially, it is also possible to form with the quality of the material which has translucency like the light emitting device 240 shown in drawing 12 . In this case, the optical passage section 141 can be formed in the metal layer 3. By doing in this way, contribution of the both sides of the reflected light by the metal layer 3 and the transmitted light which carried out incidence to the conductive substrate 22 side of translucency through the optical passage section 141 can raise optical drawing effectiveness now. In this case, if the second Lord front face 8 of the conductive substrate 22 of translucency is covered with the second metal electrode 6, the contribution to the improvement in optical drawing effectiveness by the reflected light in the front face of the second electrode 6 is also expectable. As a conductive substrate 22 of translucency, a GaP substrate can be used, for example. Moreover, the laminated structure of the luminous layer section 4 and the metal layer 3 can adopt the same thing as drawing 2 , drawing 7 , drawing 11 , etc. as the metal layer 3 except for the point which forms the optical passage section 141.

[0044] Moreover, in order to form the optical passage section 141 in the metal layer 3, the approach of carrying out patterning of the metal layer 3 with masking etc. is employable at the time of the stratification. For example, as shown in drawing 13 (a), pattern NINGU of the metal layer 3 can be carried out at a line, and the optical passage section 141 can be formed in the shape of a slit between adjoining linear metal layer fields. Moreover, as shown in drawing 13 (b), pattern NINGU of the metal layer 3 can be carried out reticulated, and the mesh can also be made into the optical passage section 141. Furthermore, if pattern NINGU of the metal layer 3 is carried out at the letter of dispersion, or island shape as shown in drawing 13 (c), a part for the background of each metal layer field is utilizable as the optical passage section 141.

[Translation done.]